Addressing the fossil fuel co-dependency between Australia and Asia

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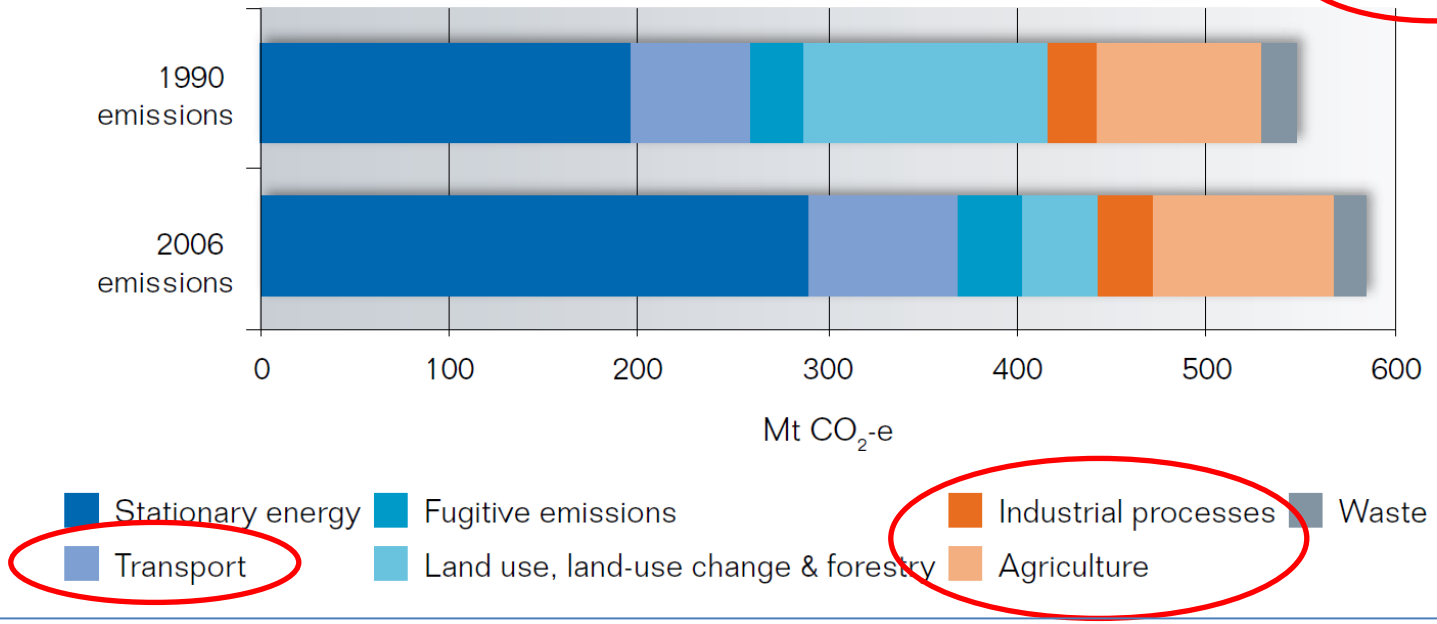
Key points

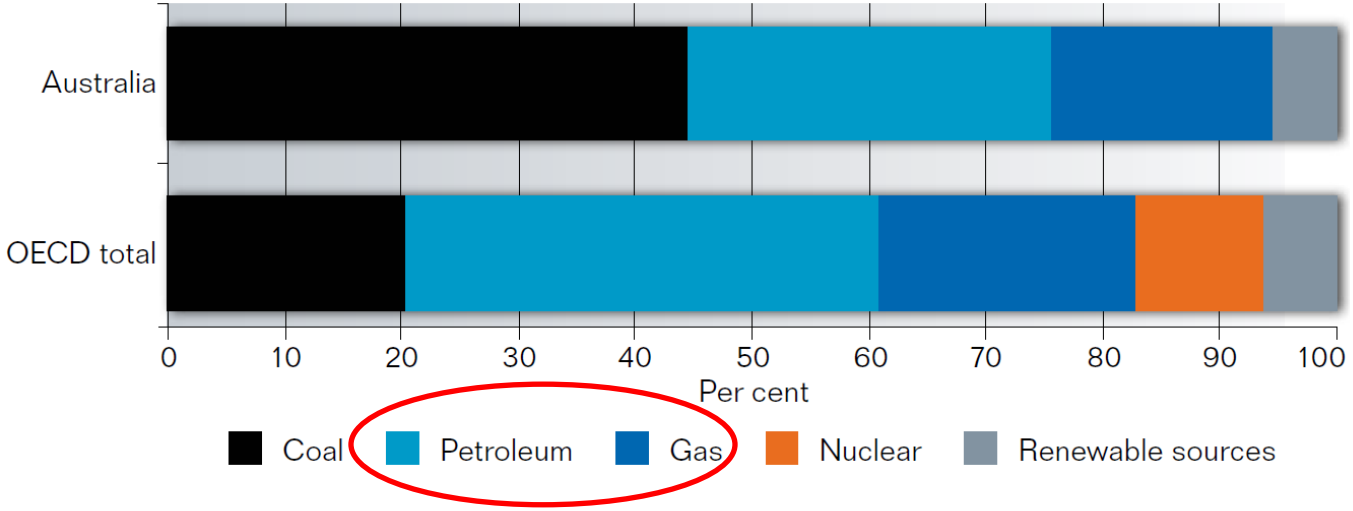
- Domestic
  - Expand domestic renewable energy supply
    - RET (Electricity) -> RETs (Energy)
  - Transport Sector
    - future developments – ICE, HEV, BEV & FCEV
  - Agriculture/Industrial Processes Sectors
    - Haber & Hydrocracking
- Export
  - Transitioning existing fossil fuel infrastructure
    - Addressing renewable electricity intermittency/oversupply
  - Instruments
    - Royalty exemption, importer's RET, Export Targets
    - Issue for CC renewable methane in IPCC Guidelines

Motivation for Renewable Energy Target(s) Domestic

Greenhouse gas emission by sector, 1990 and 2006 (excludes coal and LNG exports)



Fuel mix contributing to total primary energy supply, 2005



Comparing Australia's RET Internationally

- Renewable Electricity Target
  - Australia 20% of electricity produced by 2020
  - New Zealand 90% by 2025
  - California 50% by 2030
- Renewable Energy Target
  - European Union (28 countries) 20% by 2020
  - China 20% zero emissions by 2030
- Australian RET(s) considerations
  - Sector targeting - commercialisation readiness
  - Percentage target or fixed amount
    - LRET 41,000 GWh -> 33,000 GWh

Is a particular chemical process renewable?

- Methane sources
  - Biogas and Natural Gas
  - Sabatier process
    - $CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$
  - Methanation
    - $CO_2 + H_2 \rightarrow CO + H_2O$
    - $CO + 3H_2 \rightarrow CH_4 + H_2O$
- Hydrogen sources (for FCEV, fertilisers, explosives, hydrocracking)
  - Steam reforming (opposite to methanation)
    - $CH_4 + H_2O \rightarrow CO + 3H_2$ (Strongly Endothermic)
    - $CO + H_2O \rightarrow CO_2 + H_2$ (Mildly Exothermic)
  - $2H_2O \rightarrow 2H_2 + O_2$ (Endothermic)
    - Electrolysis (via grid or direct wind or solar PV) (Power2gas)
    - Photo-chemical (Hypersolar.com, Professor Eric McFarlane, UQ)
    - Photo-biological (biodiesel, biogas, Professor Ben Hankamer next)

Transport sector - currently

Table: Comparing CO_2 reduction efficacy of differing motor vehicle technologies

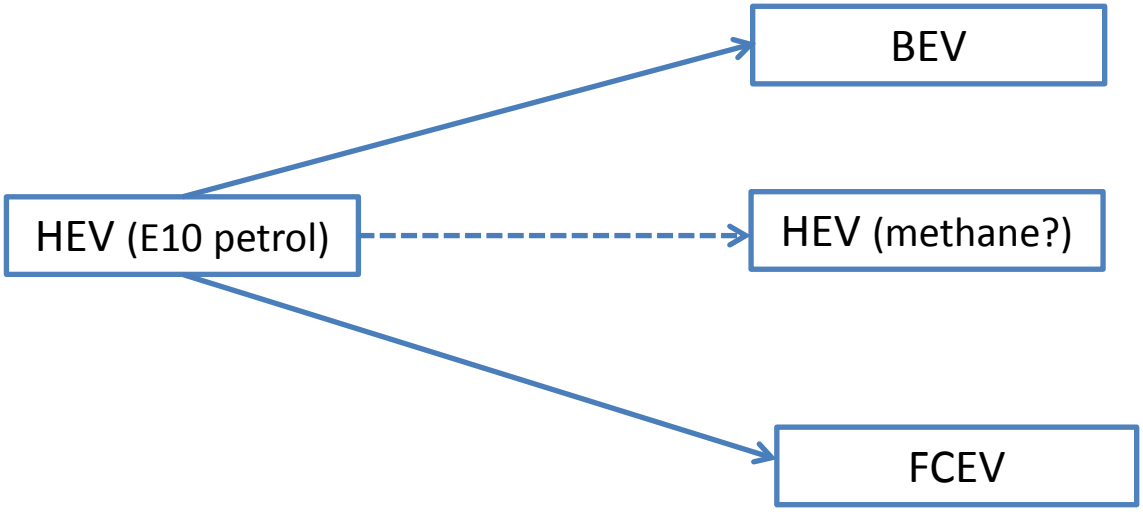
	ICE	Hybrid (HEV)	Battery (BEV)	Fuel Cell (FCEV)
Fossil indicator	E10	CO_2/km 121 (183)*	20% in 2020	(H_2?)
Fossil free score	1	4	2	1 (2 or 0)
Distribu. network	10	10	5	0
Total Score (/20)	11	14	7	1
Sample car		Toyota Camry*	Nissan Leaf/Pulsar**	Hyundai ix35***
Capital ratio Price(EV/ICE)	1	1.1 ($32,990/$28,999)	2.9 ($57,608/$20,000)	4.7 (USD144,400/$30,490)
Range anxiety			135 km (US EPA)	594 km (Hyundai)
Time of use			Recharging/batteries	Home electrolysis unit
RET(s) - distortion		Diesel-petroleum	electricity	gas

Motor Vehicle: a device that converts potential energy into kinetic energy

- * Camry http://www.toyota.com.au/compare-models/specifications?vehicleId=34,3001
- ** Nissan leaf & pulsar http://www.carsales.com.au/car/nissan/leaf/
- *** Hyundai ix35 http://en.wikipedia.org/wiki/Hyundai_ix35_FCEV

Future distribution network: Hydrogen refueling or battery recharging?

- Network effect and technological lock-in
  - Legacy system (petrol distribution network)
  - Network externalities (telephone, internet, electricity, Facebook, Skype)
  - Technological trajectories (Betamax-VHS & BluRay-HD DVD) - wait and see
  - Economies of scales (car industry) – international decision
  - Currently, both hydrogen & electricity mostly fossil fuel based – wait and see



Australia - Focus on making the fuel sources renewable -> RET(s)

Agricultural and chemical processing sectors: transitioning to renewable hydrogen

- Currently, Hydrogen from steam reforming of methane
  - $CH_4 + H_2O \rightarrow CO + 3H_2$
  - $CO + H_2O \rightarrow CO_2 + H_2$
- Fertilizer (Fossil fuel agriculture - Ammonium Nitrate)
  - $N_2 + 3H_2 \rightarrow 2NH_3$ (Haber process)
  - 3-5% worlds natural gas or 1% world energy
  - Quadruples land productivity
- Hydrocracking fossil fuels
  - Biofuels

Transitioning to a renewable energy export

Currently

Queensland → China, Japan, Korea

Coal, LNG

Specialised LNG shipping

Natural Gas distribution & liquification plant

Natural gas distribution & Regasification plant

Hydrogen Economy Future?

Uncertain hydrogen demand

Queensland → China, Japan, Korea

Renewable Hydrogen

Specialised Hydrogen shipping

Max 10% H_2 in exiting pipes
New liquification plant

Max 10% H_2 in exiting pipes
New Regasification plant

H_2 Storage problems: brittleness, corrosion, containment

Renewable LNG Future?

LNG demand certainty

Queensland → China, Japan, Korea

Renewable LNG

Reuse all the existing infrastructure

Towards 100% renewable electricity with Power2gas

- Power2gas = Surplus electricity stored as RNG
- RNG can solve intermittence problems with existing gas generation + export surplus RNG as RLNG

Price RNG > fossil fuel natural gas

- Qld Gov. forgoes royalties
- Importers' RET compliance
- Renewable Export Targets
- IPCC GHG accounting issue!

Issue over IPCC accounting rules for international trade in GHG

	Exporter (Queensland)		Importer (China, Japan and Korea)	
	Atmosphere	Inventories	Atmosphere	Inventories
Steam reforming hydrogen	+	+	–	– (–ve => displaces existing emissions)
Renewable hydrogen	0	0	–	–
RNG from biomass	–	0	0	–
RNG from captured CO_2	–	–	0	0* (no incentive)

* If booked as (-), double count problem. In case of biomass, importer's inventory becomes (-).
(Reference: 2006 IPCC Guidelines for National Greenhouse Gas Inventories)

Conclusion (1)

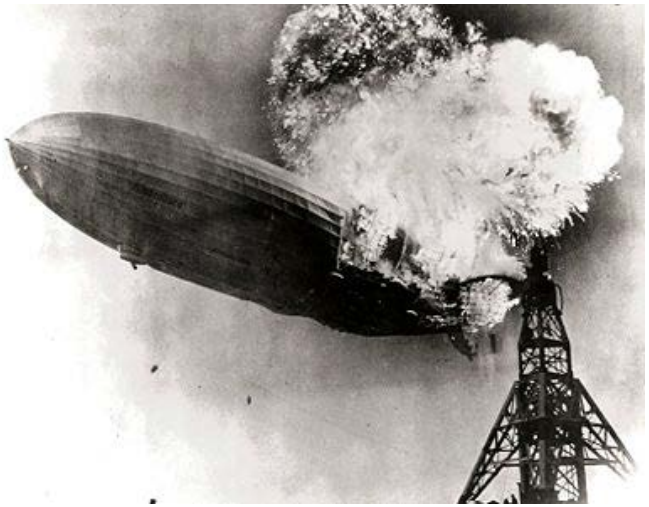
- Commercialization policy priority
  - Energy supply focus - RET(s)
    - Government service, successfully managed market solution
    - Complex problem with numerous infant industries
  - Vehicle technologies
    - FCEV or BEV wait and see
    - HEV good interim solution
- Support Time of Use (TOU) Electricity Tariffs
  - Essential prior to BEV or FCEV deployment

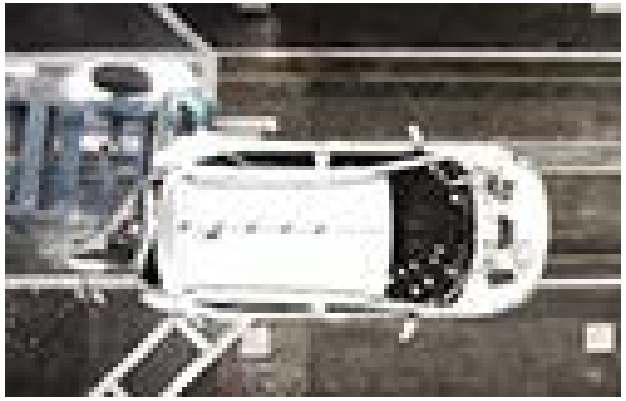
Conclusion (2)

- Exporting energy (Incentivizing energy export and import)
  - Towards 100% renewable electricity + power2gas
    - Addresses intermittency and over supply issues
    - Surplus gas exported
  - Help meet importer's RET liabilities
    - Legal and institutional arrāngement for GHG inventories
  - Improve RNG price competitiveness without royalties
    - Renewable Export Target?

Questions?

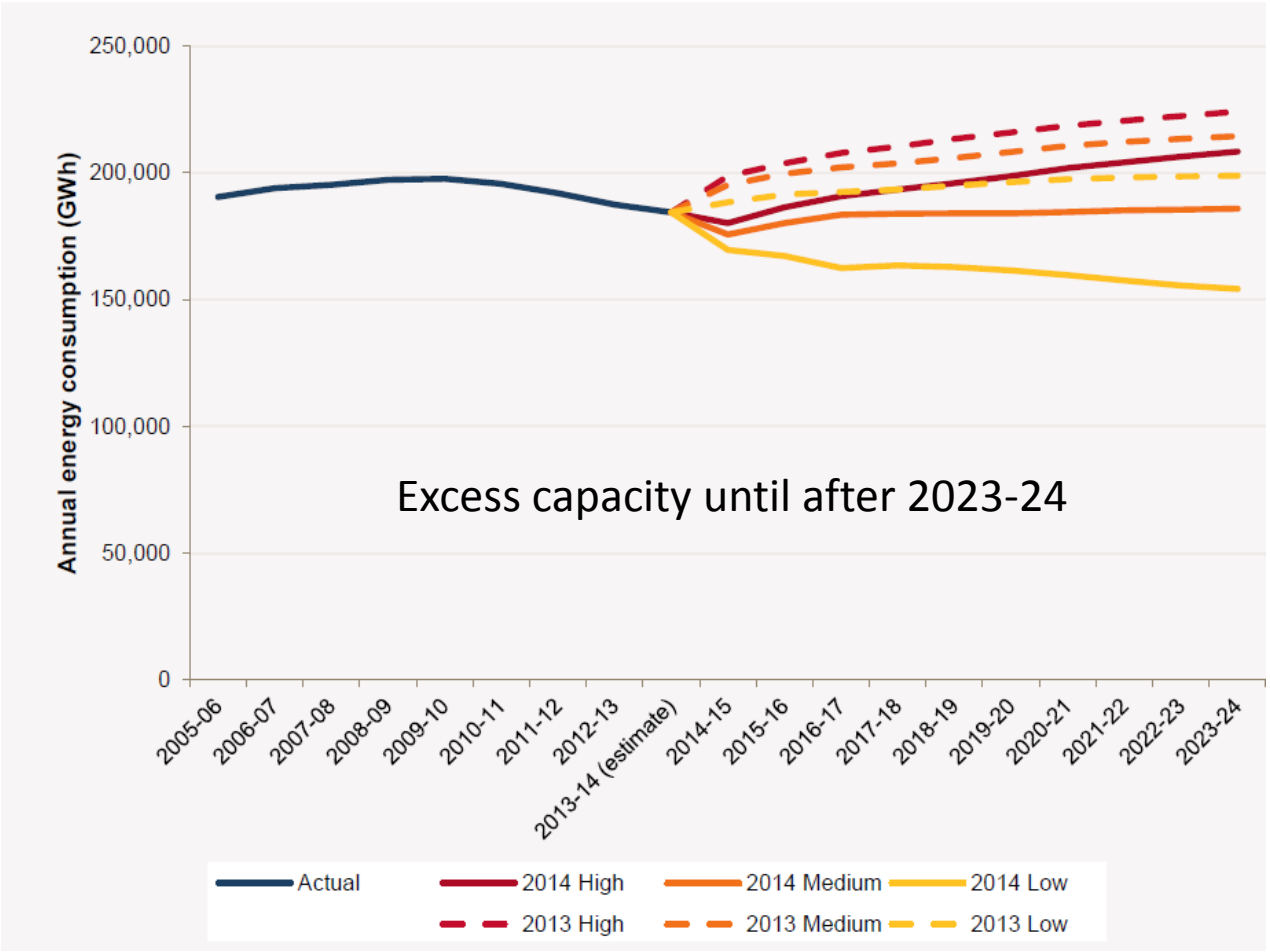
Hydrogen fear assuaging





Falling demand and oversupply of generation capacity

Figure 2: Comparison of 2013 and 2014 NEFR annual NEM energy forecasts



(Source: Australian Energy Market Operator's Electricity Statement of Opportunities 2014)

Permanent transformations

Successful CC adaptation
- LED Light bulbs
- Household solar PV
- Solar water heating
- Price awareness
- Smart meters
- Building standards
- Minimum Energy Effici.

Manufacturing decline
- Resource boom
- LNG international linkage

Irregular transformations

- ENSO - La Nina bias (Masking CC)
- GFC